# Norio SAHASHI*: Morphological and taxonomical studies on Ophioglossales in Japan and the adjacent regions (4)**

## Comparative morphology of spores of some species in Ophioglossales

# 佐橋紀男*: 日本および近隣産ハナヤスリ目の形態学的分類学的研究（4）**

## ハナヤスリ目数種の胞子形態の比較

(Pl. I-III)

Spores of three rare species of Ophioglossales were studied in detail under the light and scanning electron microscopes (SEM). They were *Ophioglossum* sp. from Isl. Aogashima, *Ophioderma simplex* and *Japanobotrychium chamaeconium*, and were compared with *Ophioglossum kawamurae*, *Ophioderma pendulum* and *Japanobotrychium lanuginosum* respectively. For the SEM observations, both mature and immature spore materials were treated with the critical point dry method before spattered with gold.

1) *Ophioglossum* sp. similar to *O. kawamurae* Tagawa: Isl. Aogashima, Izu Isls., Tokyo, Nov. 1954. M. Mizushima (TI); ibid. Nov. 1976. N. Sahashi (TOHO) (Pl. I. D-F; Fig. 3 M-N).

Shape: Tetrahedral, trilete. Amb rounded triangle (RT) to subtriangle (ST), proximal part (PP) flatly pyramidal, distal part (DP) hemispherical with crenate side. Size: 28 (24-32) × 32 (30-34) $\mu$m. Laesura: 9-15 $\mu$m long, more or less prominent up to 3 $\mu$m tall at the proximal pole, and fading off toward the tip. Exine: Light yellow, semitransparent, 2-4 $\mu$m thick with sculpture, foveo-reticulate on the distal face (DF), muri 2-6 $\mu$m broad, lumina 2-4 $\mu$m in diameter, nearly smooth or faintly pitted on the proximal face (PF). In the SEM observations, DF provided with conical depressions c. 2-4 $\mu$m in diameter, c. 2 $\mu$m deep, PF with roughly spaced punctate, less than 1 $\mu$m in diameter or much reduced as in DF. In highest magnification the fine granules are densely spaced all over the surface except in the conical depressions.

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* School of Pharmaceutical Science, Toho Uiversity, Funabashi, Chiba Pref., 274. 東邦大学薬学部

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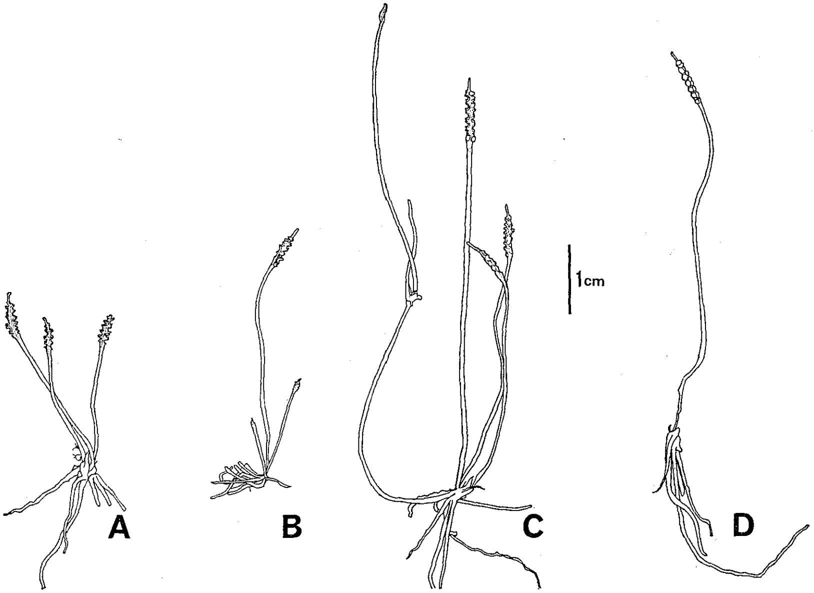

Fig. 1. A-D. Type specimens of *Ophioglossum kawamurae* (KYO). A. Three fertile stalks come up from a rhizome. B. Two fertile stalks come up from a rhizome. C. A young plant comes up from an old one by a root branching. D. A fertile stalk comes up from a rhizome.

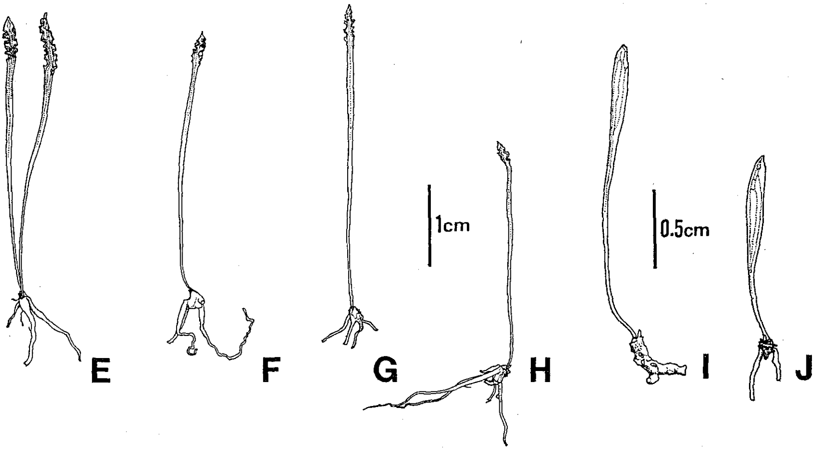

Fig. 2. E-J. *Ophioglossum kawamurae*, collected from Isl. Aogashima, Izu Isls., Sahashi 7699 (TOHO). E. Two fertile stalks come up from a rhizome. F, G and H. A fertile stalks comes up from a rhizome. I and J. A sterile leaf comes up from a rhizome.

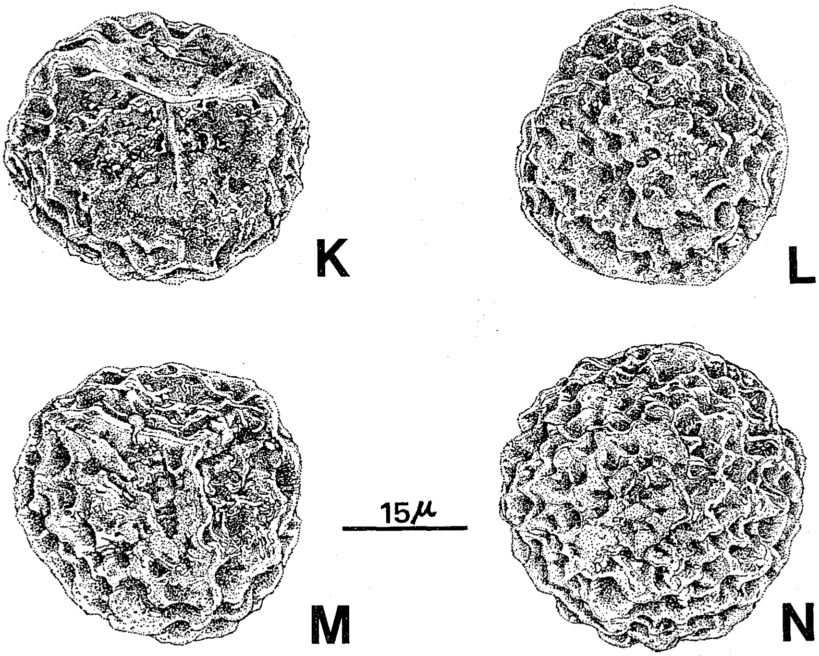

Fig. 3. K-N. A detail drawing of the spores of *Ophioglossum kawamurae*. K-L. Spores collected from type specimen (KYO). K. Polar view, proximal face. L. Polar view, distal face. M-N. Spores collected from the materials of Isl. Aogashima, Izu Isls.. M. Polar view, proximal face. N. Polar view, distal face.

Compared materials: the paratype specimen of *O. kawamurae* in KYO (Mt. Nabeyama, Sakurajima, Kagoshima Pref., Jul. 1938. Y. Doi). Nearly equal results obtained except larger conical depressions (c. 4-6 μm in diam., c. 2 μm deep) on DF (Pl. I. A-C; Fig. 3 K-L).

2) *Ophioderma simplex* (Ridley) Nishida: Buwalda 5633, Ceram, East, Kampong Kiandarat, G. Kilia, 60 m alt., 18-8-1938, and Moulton 13, Borneo, Sarawak, Tabekang upper Sadong R. (Rijksherbarium, Leiden) (Pl. II. J-L).

The spores of these specimens were immatured. They seem to be very young immediately after the division from tetrad stage.

Shape: Tetrahedral, trilete. Amb usually ST, PP concave, DP convex. Size: 34(30-39) μm in equatorial diameter. Laesura: 15-22 μm long, somewhat prominent up to 3 μm tall at the proximal pole and extend toward tip. Exine (sporoderm): Transparent, very thin, about 1.5 μm thick, often outer perine layer adhere in partially. In the SEM observations, small pitted (holes) are provided with densely spaced all over the surface but much reduced on the contact area. These pits are closed and regularly depressions, up to 0.5 μm in diameter.

Compared species: *O. pendulum* (materials from Isl. Rota, Mariana Isls., Dec. 1977. N. Sahashi (TOHO); ibid. Jun. 1979. I. Ueda (TOHO)). Careful observation was made on the same young spores as shown in Pl. II. J-L, and obtained fairly equal results as in *O. simplex*, except for exine (sporoderm) ornamentation. Namely under the SEM, small pits are scattered all over the surface but much reduced on the contact area. These are provided with roughly and somewhat irregularly, up to 0.5 μm in diameter (Pl. II. G-I).

3) *Japanobotrychium chamaeconium* (Bitter et Hieron. ex Bitter) Nishida ex Tagawa: Bambui, Bamenda, Cameroons, Dec. 1952. C. D. Adams (BM) (Pl. III. P-R).

Shape: Tetrahedral, trilete. Amb ST to triquete (TQ), PP flatly pyramidal, DP hemispherical. Size: 24(22-26) × 27(25-30) μm. Laesura: 13-20 μm long, fairly prominent up to 5 μm tall at the proximal pole and generally extend to the tip. Exine: Light yellow, about 2 μm thick, semitransparent with large irregualr convolute ridges up to 3 μm tall, c. 4 μm broad on the distal face, PF much reduced pattern as in DF or minutely pitted. In high magnification under the SEM, the fine striate or fingerprint-like pattern is clearly shown on the convolute ridges.

Compared species: *J. lanuginosum* (materials from Thailand, no. 14957 (KYO); Nepal, Helambu, Sept. 1978. M. Togashi & H. Izumi (TOHO)). They were already described in detail by Kato and Sahashi (1977). The description agrees almost with the present species particularly in the fingerprint-like pattern on the convolute ridges (Pl. III. M-O).

## Discussion

1) *Ophioglossum* sp. similar to *O. kawamurae* Tagawa (1939) used in this study was found for the first time at Isl. Aogashima, a small volcanic island, Izu Islands in November 1954 by Dr. M. Mizushima. He (1955) suggested that this trophophyll-lacking species differs from *O. kawamurae* which was collected at Isl. Sakurajima, a small volcanic island, Kagoshima Pref. in August 1935 by Z. Kawamura (holotype in KYO; Fig. 1 A-D) and in July 1938

by Y. Doi (paratype in KYO) in having smaller size and the venation of stalk forming no reticulation. Then Nishida (1957) investigated the vascular type of Aogashima species and found that it bears a close resemblance to *O. kawamurae*, but he reserved to determine it as *O. kawamurae*. In November 1976, the author also collected some trophophyll-lacking species (Fig. 2 E-J) including those which lack sporangia (Fig. 2 I-J) in Isl. Aogashima. After his careful observation led that no definite difference in spore chracters, size of stomata and venation of stalks between *O. kawamurae* (paratype in KYO) and Aogashima species (Fig. 2 E-H). From these results he concludes that both plants are identical.

2) *Ophioglossum simplex* Ridley is related to *O. kawamurae* in appearance, but the former has a rudimentary trophophyll on the fertile stalk. On the basis of the vascular anatomy, Bower (1904) considered that *O. simplex*, *O. intermedium* and *O. pendulum* are grouped into sect. Ophioderma after Prantl (1883). Clausen (1938) treated that the above three species belong to his subgenus Ophioderma. Nishida made a combination *Ophioderma simplex* (Ridley) Nishida (1959), after his anatomical survey (Nishida, 1957). The present study supports these results very well, that is, *Ophioderma simplex* with rudimentary trophophylls and *O. pendulum* with normal trophophylls.

3) *Botrychium chamaeconium* Bitt. et Hieron. was described from tropical Africa, and Ballard (1934) found its nearest ally in the Indian *B. lanuginosum*. Clausen (1938) regarded that this species is more closely related to *B. virginianum* than *B. lanuginosum*. Recently Kato and Sahashi (1977) demonstrated that *B. lanuginosum* is referred to subgenus Japanobotrychium Masamune (sect. Lanuginosae after Clausen, 1938), and also *B. chamaeconium* may be another species referable to this subgenus. In the present study, the author found that the spores of *B. chamaeconium* very closely resemble those of *B. lanuginosum*, especially in their fine structure on the spore surface of quite similar features (Pl. III. O, R). From these results, it is concluded that *Botrychium chamaeconium* is another species referable to subgenus Japanobotrychium. Concerning to taxonomy of subgenus Japanobotrychium (Kato and Sahashi, 1977), the author considers that the subgenus must be a separate genus. Therefore, in the present paper he adopted the names *Japanobotrychium lanuginosum* (Wall. ex Hook. et Grev.) Nishida ex Tagawa and *J. chamaeconium* (Bitter et Hieron. ex Bitter) Nishida ex Tagawa (Tagawa,

1958).

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## References

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## Explanation of Plates I-III

Pl. I. Comparative spore morphology of *Ophioglossum kawamurae* from Isl. Sakurajima, Kagoshima Pref. (paratype in KYO; A-C) and from Isl. Aogashima, Izu Isls. (D-F). A and D. Polar view, proximal face showing faintly foveolate sculpture with laesurae. B and E. Polar view, distal face showing foveo-reticulate ornamentation. C and F. A part of enlarged distal face showing conical depressions and fine granules.

Pl. II. Comparative immature spore morphology of *Ophioderma pendulum* from Isl. Rota, Mariana Isls. (G-I) and *O. simplex* from Borneo, Sarawak (J-L). G and J. Polar view, proximal face showing clearly long laesurae and smooth or faintly pitted sculpture, and with a part of outer perine layer. H and K. Polar view, distal face showing faintly foveolate (pitted) ornamentation. I and L. A part of enlarged distal face, the former (I) provided with fairly rough pitted and smooth surface, but the latter (L) somewhat densely pitted and finely granular surface.

Pl. III. Comparative spore morphology of *Japanobotrychium lanuginosum* from Nepal (M-O) and *J. chamaeconium* from Cameroons (P-R). M and P. Polar view, proximal face showing somewhat prominent laesurae. N and Q. Polar view, distal face showing large, irregualr convolute ridges. O and R. A part of enlarged distal face showing fine striate or fingerprint-like pattern on the convolute ridges.

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サクラジマハナヤスリに当てられた伊豆青ヶ島産のシダ，ボルネオ産の *Ophioderma simplex*，それにアフリカ，カメルーン産の *Japanobotrychium chmaeconium* の3種の大変稀なハナヤスリ目の植物について，胞子の光学顕微鏡と走査型電子顕微鏡による詳細な観察をした。併せて上記3種と胞子の形態を比較する意味で桜島産のサクラジマハナヤスリ (*Ophioglossum kawamurae*)，マリアナ群島ロタ島産のコブラン (*Ophioderma pendulum*)，それにネパール産などのアリサンハナワラビ (*Japanobotrychium lanuginosum*) の胞子を観察し次の結果を得た。

1. 青ヶ島産のハナヤスリはこれまで Nishida らによってサクラジマハナヤスリに大変よく似たものとされていたが，今回筆者は胞子の形態を重要視して，このものを真のサクラジマハナヤスリと同定した。

2. *Ophioderma simplex* はサクラジマハナヤスリ同様，栄養葉の退化したもので外見は両者が良く似ているが，Bower や Nishida の解剖学的見地からコブランに良く似ているとされていた。幸い筆者は本種の胞子を京都大学の岩槻教授のお世話で Leiden の Dr. Hennipman から送っていただいた。このものはかなり未熟であった

が比較に用いたコブランの未熟な胞子と大変良く似ていた。それで胞子形態学からも *O. simplex* はサクラジマハナヤスリとは異なる系統に属することが明らかとなった。

3. *Japanobotrychium chamaeconium* はアフリカ大陸唯一のハナワラビ類で，外部形態からアリサンハナワラビに良く似たものとされている (Ballard; Kato & Sahashi)。このものの胞子をイギリスの British Museum の Dr. Jermy から送っていただいた。胞子の形態はアリサンハナワラビに大変良く似ており，これまでの見解を強く支持するに足るものであった。

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○**高等植物分布資料** Material for the distribution of vascular plants in Japan.
101　**マツバラン** *Psilotum nudum* (L.) Griseb.　本種は大井次三郎，田川基二博士らの著書では，本州 (関東以西)，四国，九州の山中，樹幹および岩上にやゝまれに産するとしてあげている。1979年5月，福島県東白川郡矢祭山村の岩壁で，本種が2株生育しているのを見つけた。栃木県植物総覧 (1941) には，塩谷郡船生村佐貫の岩上に生育している記録があるが，福島県に生育しているのを見たのははじめてである。標本は10月に得たものを，茨城大学教育学部標本室に納めておいた。おそらく北限かと思われるので記録しておくことにした。

(茨城大学　鈴木昌友　Masatomo SUZUKI)

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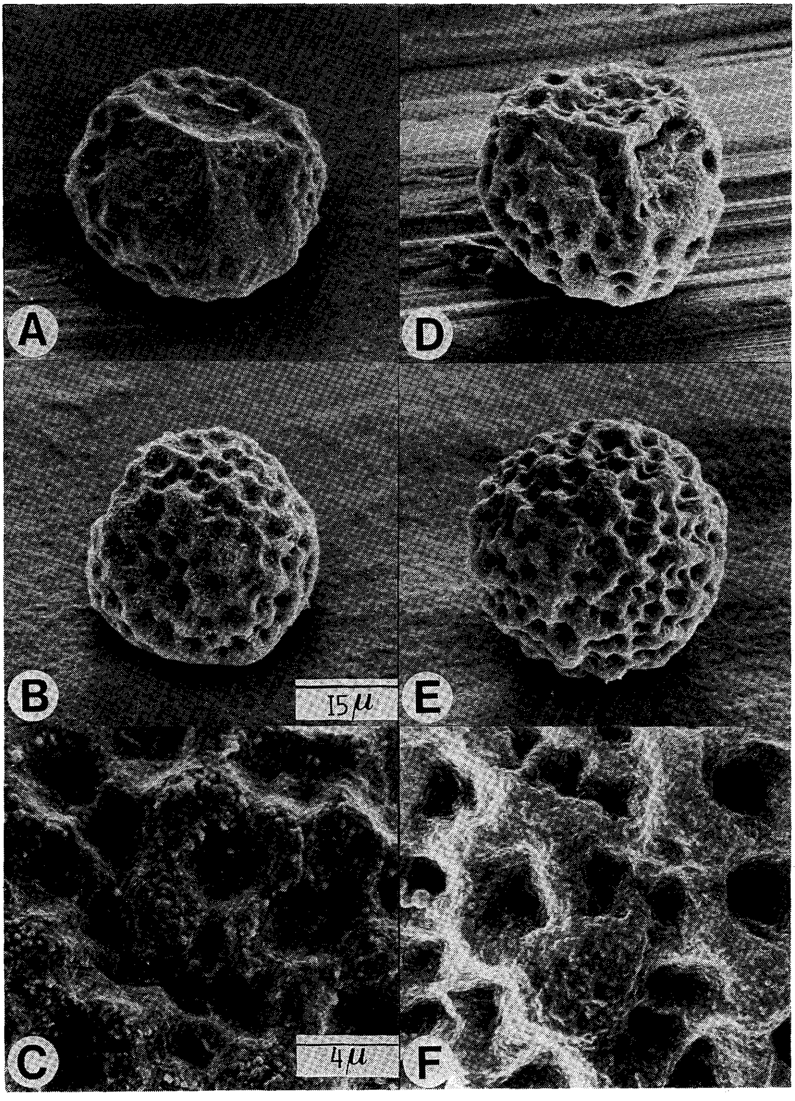
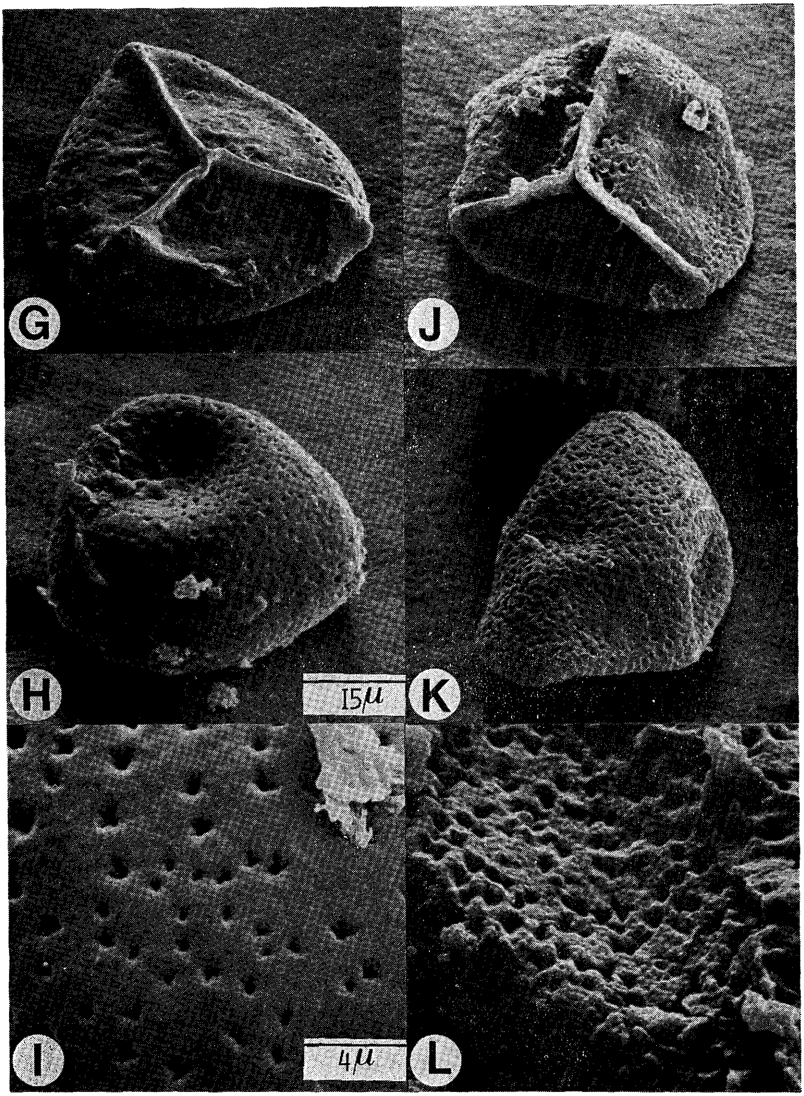
□Hara, H. & L. H. Williams: **An enumeration of the flowering plants of Nepal.** vol. 2. 220 pp. 1979. Trustees of British Museum (Natural History), London. ¥13,000.　本誌53巻335頁の新刊紹介にあるシリーズの第2巻。第1巻と構成は同様であるが，原寛博士のほかの代表編著者は，英国博物館側の停年などによる事情で変更されている。本巻にはキンポウゲ科からウコギ科までと，合弁花類ではキク科の前までが，ベンサム・フッカー方式の順に収容されている。最後部に本巻で発表された新学名が25リストされている。また11項目の正誤を印刷した紙片がはさまれている。大小103の科の中，原氏のまとめたもの約50科，Whitmore 博士のもの約30科があり，他に16名の協力者がある。その中には故 J. E. Dandy 博士，W. T. Stearn 博士，および，S. Y. Sutton，O. Chater の諸氏がある。日本側の協力者としては，籾山泰一 (ブドウ科)，大橋広好。(マメ科，バラ科のナシ亜科の諸属，キジムシロ属など)，大場秀章 (ベンケイソウ科) の諸氏がある。*Desmodium* および近縁属の種への Key, *Hedysarum, Rhynchosia, Sedum, Rhodiola, Hypericum* などの種への Key がついている。なお，ネパールで栽培されている種も適当に登載されている。全体の編集の実務はほとんど原寛氏がした。この出版は日英協同の大きい成果を示している。続く第3巻での完成を待ちたい。東京，本郷，井上書店で取扱い中。

(津山　尚)



N. SAHASHI: Ophioglossales in Japan



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